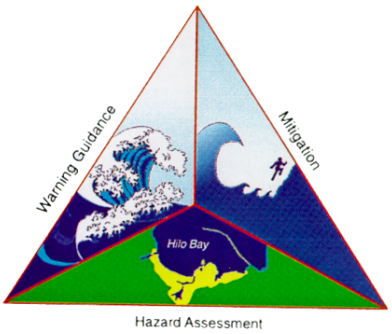
1997-1999 Activities of the Tsunami Mitigation Subcommittee

Alaska, California, Hawaii, Oregon, Washington, FEMA

By Chris Jonientz-Trisler (Subcommittee Coordinator) & Jeanette Mullin, FEMA

Building Safer Coastal Communities

A Report to the Steering Committee
National Tsunami Hazard Mitigation Program
NOAA, FEMA, USGS
Alaska, California, Hawaii, Oregon, Washington



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ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

This report documents progress and provides information about tsunami hazard mitigation products and activities produced by the Mitigation Subcommittee of the National Tsunami Hazard Mitigation Program (NTHMP). The Subcommittee includes representatives from the States of Alaska, California, Hawaii, Oregon, Washington, and is chaired by a representative from the Federal Emergency Management Agency (FEMA).

Each State Program develops products in order to promote *"tsunami resistant communities"*. In addition, States collaborate on "multi-State projects" by pooling resources to address common issues to benefit several States. The States' activities for the period from 1997 through mid-1999 are summarized on pages 5-8. A table is organized according to the strategic planning areas identified in the Strategic Implementation Plan which defines, prioritizes and coordinates the Subcommittee's efforts. (Specific information about this plan is found in the Introduction.) Activities in the table are explained more fully in the State specific portion of the report.

Each State also chose a project that especially demonstrates what helps build a *"tsunami resistant community"* and these are highlighted in the report. Alaska's inundation mapping partnership was established to involve local community leaders in the mapping process and give them ownership of the project. California's building of a Tsunami Hazard Mitigation Constituency brought together federal, state, and local officials responsible for emergency and coastal zone management to develop California's strategic plan for tsunami hazard mitigation. Hawaii's Tsunami Working Group brings together representatives from the state and county emergency management departments, Pacific Tsunami Warning Center, US Geological Survey, and local tsunami experts to improve and update usability of tsunami information and procedures. Oregon's coastal communities were assisted in development of their own local tsunami evacuation brochures. Washington's tsunami warning and evacuation sign program emphasized the cooperation of the counties in installation of interpretive and evacuation signs along coastal roads and highways and is consistent with signs placed along the Oregon coast.

The multi-State projects involve several States sharing development input and review and products resulting from them. Oregon led a project to develop tsunami public education materials, including bookmarks, brochures, posters, magnets, hazard zone decals, coffee mugs, etc. Washington led creation of a Tsunami Information System for local emergency managers, officials, and others which distributes new research and other information through a newsletter, the *TsuInfo Alert*. Washington also coordinated publication of *Tsunami Survival - Lessons from Chile* that provides vivid accounts (and lessons for the future) of how people survived, or didn't survive, the 1960 Chilean tsunami. Two projects underway currently are local guidance documents for tsunami warning systems and structures and land use.

As this report demonstrates, the five States have accomplished many activities towards reducing tsunami risks. Besides just documenting their productivity, however, the States' ultimate goal is to make the National Tsunami Hazard Mitigation Program truly national by transferring the information and products they have developed to other affected jurisdictions within the United States and beyond. The States hope their efforts will save individuals, not only in their own States, but also in all affected jurisdictions in the United States and potentially around the world.

INTRODUCTION

Purpose

The purpose of this report is to document progress and disseminate information about tsunami hazard mitigation products and activities supported by the National Tsunami Hazard Mitigation Program (NTHMP). The States of Alaska, California, Hawaii, Oregon, and Washington have highlighted products and activities as models for other states and territories based upon their success or expected success in reducing tsunami hazards.

Background

A number of scientific investigations published in the 1980's showed that large subduction zone earthquakes had occurred along the Pacific Northwest coast of the United States in past centuries and were likely to do so again in the future, causing significant damage and loss of life to the five states. In 1992, an earthquake near Cape Mendocino in northern California produced a small tsunami which arrived at nearby coastal communities within twenty minutes of the earthquake. In 1994, a distant tsunami warning for the West Coast tested the state of tsunami readiness on the Cascadia coast. A survey of West Coast communities revealed disparate responses occurred as a result of the warning (see appendix A for copy of report). These events led toward the formation of the National Tsunami Hazard Mitigation Program to provide a consistent message and plan of action to mitigate tsunami risk.

National Program

The National Tsunami Hazard Mitigation Program is a Federal/State partnership to reduce risks from tsunamis. The National Oceanographic and Atmospheric Administration (NOAA), the Federal Emergency Management Agency (FEMA), the United States Geological Survey (USGS), and the States of Alaska, California, Hawaii, Oregon and Washington have pooled their various expertise to reduce risk as charged by Congress by the following actions:

1. Assessing tsunami hazards,
2. Facilitating communication of hazard information,
3. Improving early detection of tsunamigenic earthquakes,
4. Reducing false tsunami alarms,
5. Supporting tsunami mitigation efforts for at-risk communities.

The National Program can be represented by a triangle whose three sides support each other. "Mitigation" is one part of the triangle. The other two parts include "Warning Guidance" and "Hazard Assessment." NOAA leads development of a system of deep-water buoys to provide better warning and real time information by detecting tsunamis at sea. NOAA also staffs the Tsunami Inundation Mapping Effort (TIME) Center that provides or assists with modeling efforts for the creation of tsunami inundation maps and will archive the mapping processes and products. NOAA chairs the Steering Committee and is the recipient of Congressional funding for this program. NOAA distributes some of this funding to the USGS and FEMA for implementation of their roles in the program. FEMA further distributes funding to the five states for both state and multi-state projects. FEMA holds the leadership role in coordinating

development of mitigation programs, products, and activities within the Mitigation Subcommittee. Similarly, the USGS leads enhancement of existing seismic networks to provide real time detection of tsunamigenic earthquakes.

For more information on the program and updates on projects, visit the National Tsunami Hazard Mitigation Program website at http://www.pmel.noaa.gov/tsunami-hazard.

Mitigation Subcommittee

The Mitigation Subcommittee is a subgroup of the Steering Committee of the National Tsunami Hazard Mitigation Program. The Subcommittee is currently made up of representatives from all five states and FEMA Region 10 whose representative holds the role of Coordinator of the Subcommittee. The Subcommittee is charged with developing tsunami hazard mitigation programs at the State and local levels. A key component of these programs includes working with local officials to develop useful mitigation products and to facilitate use of new inundation maps being developed under the National Program. Inundation maps are being developed in conjunction with the Tsunami Inundation Modeling Effort (TIME) and geoscientists chosen by the States to provide local data. These geoscientists are working with TIME modelers to turn the modeling data into usable maps.

Strategic Implementation Plan

The Subcommittee saw a need for a strategic implementation plan that would define, prioritize, and coordinate the mitigation efforts of the National Program. Recently, the Subcommittee approved such a plan for submittal to the Steering Committee. It is available from NOAA as NOAA Technical Memorandum ERL PMEL-113, *Strategic Implementation Plan for Tsunami Mitigation Projects*, L. Dengler, October 1998. It emphasizes the efficient use of available resources, implementation of the technical results of the National Program at the state and local level, collaboration and sharing of information among the states and Federal agencies, incorporation of tsunami issues into existing all-hazards programs, and the reporting and dissemination of program results.

The Plan's goal is *"A tsunami resistant community"* that:

1. Understands the nature of the tsunami hazard.
2. Has the tools it needs to mitigate the tsunami risk.
3. Disseminates information about the tsunami hazard.
4. Exchanges information with other at-risk areas.
5. Institutionalizes planning for a tsunami disaster.

The Strategic Plan provides a framework for the development of specific tools and policies for states and local communities to reduce the impact of future tsunamis. The plan addresses five strategic planning areas:

1. Education
2. Tools for Emergency Managers
3. Construction, Abatement and Land Use Guidance
4. Information Exchange and Coordination
5. Long-term Tsunami Mitigation (including recovery planning)

Incentives must be found to encourage action in these areas.

Activities supported by the Mitigation Task of the National Program are in the following areas of emphasis:

1. Improve tsunami education.
2. Provide tools to supply guidance and support local planners and emergency managers.
3. Create and strengthen links within and among states to support long-term tsunami mitigation.
4. Improve the mitigation science infrastructure.
5. Encourage innovation and local sponsorship of tsunami mitigation programs.

This plan's approach to achieving the goal involves a four year intensive development effort followed by continued sustained effort:

Year 1:	Assessment of needs and resources
Year 2:	Feasibility studies and product development
Year 3:	Product development and implementation
Year 4:	Implementation, and evaluation
Year 5 and beyond:	Implementation and maintenance

PART 1

STATE TSUNAMI PROGRAMS

Tsunami Activities Matrix

	Alaska	California	Hawaii	Oregon	Washington
Planning Element - Education					
Evacuation & Educational Signage	✍	✔, ✍	P	✔	✔
Media Materials		P		✔	✔
Public Info Products	P	P, ✔	P, ✔	M,✔	✔
Public Service Announcements		P	P	✍	
Cost/Benefit of Tsunami Mitigation for Businesses			P		
State Videos			✍	✔	✔
Curriculum Materials		✍	P	✔	✍
Library-type Materials Inventory			✍		✔
Training Materials		✔	P		
Tsunami Info for Tourists		✔	P	M, ✔	✔
Tsunami Info for State & Local Officials		✔	P	✔	✔
Public Education		P, ✔	✔	M, ✔	M, ✔, ✍

✔ Activity Accomplished During the National Program

✍ Under Development

P Produced before the National Program began

M Multi-State Project

Tsunami Activities Matrix

	Alaska	California	Hawaii	Oregon	Washington
Planning Element - Tools for Emergency Managers					
Inundation Maps	✍	P, ✍	P,✔	P, ✔, ✍	✍
Evacuation Routes	P	P, ✔	P	✔, ✍	✔
Evacuation Brochure			P	P, ✔, ✍	✍
Warning Programs	P	P, ✔,✍	P	P, ✔, ✍	✍
Local Warning System Guidelines			P	M(✍)	
Guides for Unmapped Communities	P	P			
Non-Strategic Plan Activities					
Community Needs Assessments	P, ✔	P, ✔		✔	P, ✔
Surveys	P, ✔	P, ✔		P, ✔	P

✔ Activity Accomplished During the National Program

✍ Under Development

P Produced before the National Program began

M Multi-State Project

Tsunami Activities Matrix

	Alaska	California	Hawaii	Oregon	Washington
Planning Element - Building and Land Use Guidance					
Codes and Construction Guides		M(✍)	P		
Zoning Regs and Land Use Guides		M(✍)	P	P	
Infrastructure Guides					
Vegetation Guides		M(✍)			
Vertical Evacuation Guides			P		
Planning Element - Information Exchange and Coordination					
Coastal Jurisdiction Contact	P, ✔	P, ✔	P	✔	✔
Meetings between different disciplines	P, ✔	P, ✔	P	✔	✔
Resource Center to Catalog Mitigation					M
Web Page Development		P, ✔	P, ✔	✔	✔

✔ Activity Accomplished During the National Program

✍ Under Development

P Produced before the National Program began

M Multi-State Project

Tsunami Activities Matrix

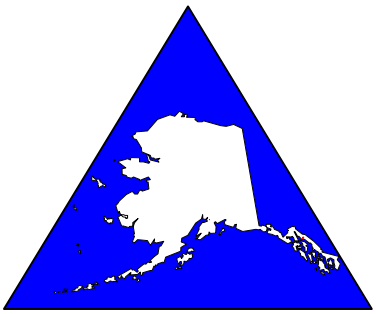
	Alaska	California	Hawaii	Oregon	Washington
Planning Element - Information Exchange and Coordination (continued)					
Working with non-program States, Territories			P	✔	✍
Tsunami Workshops		P, ✔	P	✔	✔
Access to Tsunami Technical Advisor	P		P	✔	
Planning Element - Long-Term Tsunami Mitigation					
State/Local Tsunami Work Groups	✔	✔	P	✔	✔
State Tsunami Mitigation Planning		✔	P	✍	
Incorporate Tsunami into All-Hazards Planning					
Post-Tsunami Recovery Guide					
Non-Strategic Plan Activities					
Loss Estimation					
Local Gov't Tsunami Planning Guidance		✔			
Tsunami Legislation				P	

✔ Activity Accomplished During the National Program

✍ Under Development

P Produced before the National Program began

M Multi-State Project



State Tsunami Program
State of Alaska

EDUCATION

Evacuation & Educational Signage:
Evacuation signs save lives by directing people along appropriate routes to safe places away from the tsunami. Kodiak communities will be receiving tsunami inundation maps soon and are interested in placing evacuation signs. The Alaska Division of Emergency Services (ADES) is also working with Sitka to purchase and place signs. Other communities will receive similar assistance.

Public Information Products:
Pamphlets and brochures serve to educate the public to the tsunami hazard and advise them how to stay safe. ADES will continue to provide these to communities.

TOOLS FOR EMERGENCY MANAGERS

Community Needs Assessment:
Community needs assessments provide the basis for prioritizing and implementing mitigation solutions. ADES is establishing a database for 100 coastal communities to include community profiles, historical earthquake/tsunami data, known sources and availability of data, identifying existing plans and populations at risk, selecting evacuation routes, providing shelter information and identifying communications capabilities and limitations.

Inundation Maps:
Inundation maps save lives by providing information ahead of time about the potential for tsunami impact in certain areas. Communities can better plan safe egress routes. The maps may also serve as a catalyst for thought about placing future critical facilities in projected impact areas. Geophysical Institute staff at the University of Alaska Fairbanks are developing current maps for Kodiak and long term expertise in tsunami modeling to serve Alaska in the future (see case study).

Evacuation Routes:
Appropriate evacuation routes save lives by considering where people would most safely be able to leave potential tsunami impact areas. Knowing ahead of time where the tsunami is less likely to reach, where bridges may be out, and where landslides may accompany an earthquake associated with the tsunami allows routes to be planned through less dangerous areas before the event.

Warning Programs:
Warning programs save lives by alerting people to the arrival of a potentially dangerous tsunami if time allows and educate them how to respond when the warning is given. Alaska is fortunate to be

the home of the Alaska and West Coast Tsunami Warning Center (ATWC). ATWC and ADES have had a close relationship for many years and continue to work together to provide efficient warnings to Alaskans. Some communities previously impacted by tsunamis have developed their own local warning system. ATWC takes their outreach program on the road to the West Coast to inform those communities how best to react to warnings they provide.

Guides for Unmapped Communities:

In years past, communities often used the 100 foot contour as the basis to plan their evacuation safe areas. With new knowledge and new technology, more factors can be taken into account including the fact that tsunami wave velocity diminishes with distance as it runs inland, and buildings and vegetation can deflect or slow down the wave in some cases. Other factors should be used in planning routes such as hillsides susceptible to landsliding during earthquakes and ground under bridges that is susceptible to liquefaction.

Surveys:

A 1980s survey of approximately 100 communities allowed rating for tsunami risk as high, medium or low hazard. During the 1990s, ADES redesigned the survey to include other factors related to tsunami and update their baseline information. This new material is being used in a community needs assessment to prioritize scarce resources to meet these needs.

1964 tsunami high water mark on Coast Guard facility in Kodiak, Alaska. Photo: Chris Jonientz-Trisler, FEMA.

INFORMATION EXCHANGE AND COORDINATION

Coastal Jurisdiction Contact:

Local jurisdictions must be included in the process of building a Tsunami Program in order to ensure local ownership of the risk and solutions. Local jurisdictions know best what their needs and priorities should be. ADES staff works through Local Emergency Preparedness Councils (LEPC) to pass information through presentations to the communities and to assist them.

Meetings Between Different Disciplines:

Different disciplines have different views, needs and resources. ADES brought together seismologists, tsunami modelers, geologists, emergency managers at all levels, the Coast Guard, and borough and city officials in order to work together on a tsunami inundation mapping project.

State Tsunami Advisor:

A Tsunami Advisor serves as a valuable source of historical, scientific, and practical information during the tsunami crisis. The Alaska Tsunami Warning Center staff has provided this service to the emergency management community both in times of crisis and during planning activities.

LONG-TERM TSUNAMI MITIGATION

A State/Local Tsunami Work Group can support a tsunami program or activity very effectively. In Alaska, such a group known as The Blue Ribbon Panel was formed specifically to work with local communities in creating tsunami inundation maps and is made up of scientists representing seismology, tsunami modeling, and geology. It also includes emergency managers to guide the usefulness of the maps.

For More Information, Contact:

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Or

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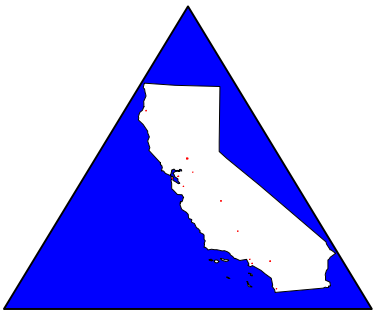
Damage in Kodiak, Alaska, from the 1964 Tsunami. Photo: U.S. Navy.



State Tsunami Program
State of California

EDUCATION

Evacuation & Educational Signage:

Informational and evacuation signage has been developed and installed in Crescent City, Del Norte County. Interpretive signs are being installed in Redwood National Park providing general information about tsunamis. Trail head tsunami hazard signs will be installed this year. The City of Eureka is reviewing proposals for evacuation zone mapping and signage. As inundation maps become available, other vulnerable counties will develop evacuation plans and signage programs. Interpretive signs are planned for areas subject to inundation in Del Norte and Humboldt Counties.

Both Crescent City (harbor siren installed at this time) and Eureka are considering installation of siren warning systems.

Media Materials:

Media materials help raise general public awareness. Background material and media kits have been developed for the north coast. The California Earthquake Program has developed a public information brochure for distribution in areas subject to inundation. San Mateo County developed an education videotape that has been distributed to all coastal jurisdictions. Additional video materials, purchased from the National Tsunami Mitigation Program, have been distributed to school districts in all coastal counties.

Public Information Products:

Pamphlets and brochures educate the public on the tsunami hazard and how to remain safe. In addition to the brochure and video noted above, Humboldt State University developed and distributed *Living on Shaky Ground: How to Survive Earthquakes and Tsunamis on the North Coast*. The brochure has been distributed to residents of Del Norte, Humboldt, and northern Mendocino Counties. California modified Oregon's tsunami brochure and is distributing it.

Public Service Announcements:

PSAs provide information before and during a crisis. PSAs on the dangers of earthquakes and tsunamis were developed by the Humboldt Earthquake Education Center and Dell'Arts Education Through Arts Project in Humboldt County, and broadcast over local cable channels in the north coast region.

Curriculum Materials:

Humboldt State University faculty developed materials on the threat of tsunamis for integration into primary and secondary science education programs. The materials are an augmentation to

FEMA and California curricula on earthquakes, the geosciences, and disaster preparedness. Additional materials are under development and will be disseminated to coastal counties' offices of education for local distribution to schools. Humboldt State University offers a course, Geology 700 -- Tsunami, to teachers and student priorities.

Training Materials:

Training materials deliver the right message and exist to train emergency managers.

Tourist Information:

Tsunami information signs for hotels have been developed for Del Norte County. Tsunami information signs are being posted in Redwood National Park.

State and Local Officials Information:

A resource library on tsunamis exists to assist state legislators in making good decisions on issues.

Business park in Crescent City, California. High water mark from the 1964 tsunami has been posted on column of walkway. Photos: Chris Jonientz-Trisler, FEMA.

TOOLS FOR EMERGENCY MANAGERS

Mitigation Needs Assessment and State Tsunami Mitigation Strategic Plan:

Community needs assessments provide the basis for prioritizing and implementing mitigation solutions. The Governor's Office of Emergency Services convened a strategic planning workshop of local government emergency managers. The workshop provided hazard awareness training to the local officials and resulted in a needs assessment and strategic plan for California tsunami mitigation planning. The plan provides a guide to mitigation programs as local, State, and Federal funds become available. Priority needs, including development of guidance and maps for local governments, are being met through NOAA, State, and FEMA hazard mitigation funding. Workshop participants continue to serve as the State Tsunami Planning Steering Committee. As a result of workshop participation, the counties of Los Angeles and San Diego initiated tsunami preparedness planning efforts.

Inundation Projections:

In the aftermath of the 1992 Humboldt earthquake and tsunami, California, with the support from both FEMA and NOAA, developed and disseminated an earthquake and tsunami planning scenario for Del Norte, Humboldt, and northern Mendocino Counties. The scenario combined inundation projections with estimates of ground shaking and structural damage to provide local, State, and Federal disaster planners with a better understanding of the complexity of a near source tsunami event. Additional inundation maps are being developed with support from the National Tsunami Hazard Mitigation Program, FEMA's National Earthquake Hazards Reduction Program, and the California Governor's Office of Emergency Services (OES). The NOAA mapping program, in partnership with California OES, will develop and distribute inundation projections to San Francisco and San Mateo, Santa Barbara, Los Angeles, and San Diego Counties with current funding.

Guidance for Local Government Tsunami Response Planning:

California OES, with support from the National Tsunami Hazard Mitigation Program, FEMA's NEHRP, and State funds, developed a guidance document to assist local government emergency planners in developing response and evacuation plans. The Local Planning Guidance includes background information about the tsunami threat, Standardized Emergency Management Systems planning procedures, sample plans for cities and counties, notification procedures, and legal guidance for population evacuation. State and local government emergency managers participated in developing the guidance.

Evacuation Routes:

Appropriate evacuation routes exist where they can be based on the combination of useful information on the inundation maps.

Warning Programs:

Warning programs exist to trigger use of evacuation routes in some communities.

Guides for Unmapped Communities:

Unmapped communities often use the 100 foot contour or the highest available ground where that contour does not exist as the basis to plan safe areas. Power lines, industrial debris sources and other hazards can be noted but not always avoided. Moving far inland is not always possible either.

Surveys:

Several surveys have been done to assess community needs and to plan possible solutions.

INFORMATION EXCHANGE AND COORDINATION

Coordination Among Local and State Jurisdictions:

California OES convenes the State Tsunami Planning Steering Committee as a forum for coordination and communication of tsunami preparedness planning. The Committee provides input to State and NOAA program managers on the needs of coastal jurisdictions and provides strategic planning guidance to the California program. In addition, tsunami planning materials are reviewed by California OES for compliance and consistency with the Standardized Emergency Management

System. OES Coastal and Southern Regions provide staff support and liaison to coastal counties in implementing tsunami preparedness procedures.

Meetings Between Different Disciplines:

Different disciplines have different views, needs and resources. On the North Coast academia, emergency management, police and fire, local businesses, and others have come together to plan.

Tsunami Workshops:

Several workshops on the North Coast have provided the diverse players a forum to exchange information and ideas on how to make their community more safe. Some of these have resulted in findings and recommendations for action that are then prioritized for implementation.

Web Page Development:

Several local jurisdictions share information by web page about tsunamis.

LONG-TERM TSUNAMI MITIGATION

State/Local Tsunami Work Groups:

The Redwood Coast Tsunami Work Group (RCTWG) meets bi-monthly to coordinate local, State, and Federal agencies, and coastal land managers on tsunami planning issues in Del Norte and Humboldt Counties. The RCTWG provides support to activities in the Redwood National Park, the cities of Crescent City and Eureka, and the unincorporated areas of the two counties.

For More Information, Contact:

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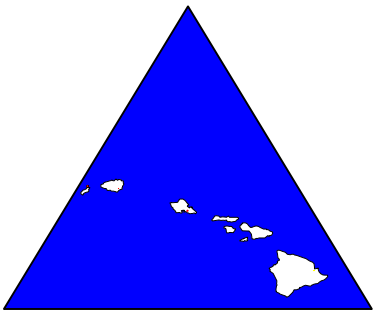
Tsunami evacuation sign in Crescent City, California. Photo: Chris Jonientz-Trisler, FEMA.



State Tsunami Program

State of Hawaii

EDUCATION

Evacuation & Educational Signage:

Hawaiians have had many tragic experiences with tsunamis within their memory. Education and evacuation information about tsunamis exists in the front pages of phone books. They have had a system of evacuation signs in place in select counties for many years.

Public Information Products:

Public memorials in open space areas draw attention to the fact that Hawaiians have died in homes and schools previously located in tsunami inundation areas. In addition, the Pacific Tsunami Museum provides material and displays in a shopping mall in Hilo.

Public Service Announcements:

Multihazard PSAs include tsunami information before and during a crisis.

Curriculum Materials:

Curriculum materials about tsunamis have been developed by Dr. Dan Walker, Dr. Doak Cox, Dr. George Curtis, Dr. Augustine Furumoto, Dr. Walter Dudley, Dr. Charles Mader, Dr. Don Thomas, Dr. Laura Kong, Dr. Carl Johnson, Dr. Gerard Fryer and others to teach younger generations what their elders know firsthand about tsunamis.

Library-type Materials Inventory:

The International Tsunami Information Center (ITIC) is developing a research resource on tsunami and houses many fine materials from around the world.

Tourist Information:

Educational and evacuation information about tsunamis exists in the front pages of phone books. There are several memorial sites tourists can visit to learn about tsunami tragedies.

State and Local Officials Information:

Much information and expertise from various agencies that research or deal with response and planning issues exist to educate government officials.

Public Education:

Several institutions are rich resources for tsunami information including the International Tsunami Information Center (ITIC), the Pacific Tsunami Museum and the Center for the Study of Active Volcanism (CSAV) at the University of Hawaii, Hilo. A tsunami coloring book has had wide

distribution among school children. Also, a new state tsunami hazard safety video will be produced as a key awareness-raising tool. It will be patterned after Oregon's tsunami video.

TOOLS FOR EMERGENCY MANAGERS

Inundation Maps:

Inundation maps have existed for years for much of Hawaii based on historical experience and local modeling. The maps have seen frequent use during warnings. Program money is being used to fill in the few gaps in mapping that still exist. Projects starting up include distant tsunami modeling that will help define the severity of a forecast tsunami and help officials know when to cancel warnings early enough to avoid a costly "false alarm." Another such project includes local tsunami modeling that will help enhance scenarios. A third project will improve the understanding of the critical relationship of modeling and tide measurements.

Evacuation Routes and Brochures:

Evacuation routes exist that have been used many times. Oahu has evacuation brochures.

Warning Programs:

Hawaii is home to the Pacific Tsunami Warning Center (PTWC) which was established to change the loss of life seen during the 1946 tsunami. The warning program has been very successful and is undergoing constant refinement particularly to try to address the issue of perceived "false alarms."

Local Warning System Guidelines:

PTWC is trying to make warnings faster to the local systems and frequently works with the locals to assist them in improving their systems.

Restaurant near Hilo, Hawaii, showing high water marks for 1957 and 1960 tsunamis. Photo: Chris Jonientz-Trisler, FEMA.

BUILDING AND LAND USE GUIDANCE

Codes and Construction Guides:
Codes and construction guides ensure that buildings are safer. Local county building codes exist.

Zoning Regulations and Land Use Guides:
Zoning and land use ensure that sites are safer. Hilo did not rebuild a community in its tsunami-impacted area but instead built a memorial with open space for people to enjoy but not inhabit. There is, however, no restriction on development. A school at Laupahoehoe was relocated far uphill after two dozen children and teachers were lost to a tsunami crashing into the original school buildings and surrounding staff homes. The grounds are now open space with a memorial stone.

Vertical Evacuation Guides:
Vertical evacuation is used by hotels with open lobbies. Visitors are directed to go to higher floors in the event of a tsunami.

INFORMATION EXCHANGE AND COORDINATION

Coastal Jurisdiction Contact:
County Civil Defense officials meet on a regular basis with the State Civil Defense staff, Warning Center staff and others to discuss tsunami issues.

Meetings Between Different Disciplines:
Academia, Warning Center staff, and emergency managers work to improve the warning system.

Tsunami Workshops:
Tsunami workshops occur regularly in Hawaii and benefit from a rich slate of tsunami experts in the state and draw international experts to provide their own experience into the mix.

Web Page Development:
Several tsunami web sites exist including: Oahu County, the Pacific Disaster Center (PDC), and the Pacific Tsunami Museum.

State Tsunami Advisor:
Hawaii has a long tradition of a Tsunami Advisor that is available to the State Civil Defense to answer questions and provide needed advice during a tsunami crisis.

LONG-TERM TSUNAMI MITIGATION

State/Local Tsunami Work Groups:
State Civil Defense coordinates meetings with the county Civil Defense officials and tsunami scientists including PTWC several times a year or when an issue arises in order to continue to improve Hawaii's ability to save lives from tsunamis.

State Tsunami Mitigation Planning:

Tsunami mitigation planning is done at the State level as well as at the local level.

For More Information, Contact:

Brian Yanagi **(808) 733-4300 ext 552**
State Civil Defense **byanagi@scd.state.hi.us**
Or
Augustine Furumoto **(808) 395-1485**
Consultant **gusf@hgea.org**

April 1, 1946 tsunami breaking over Pier No. 1 in Hilo Harbor, Hawaii. The man in the foreground became one of the 159 fatalities in the Hawaiian Islands from the tsunami. Photo: NOAA/EDIS.

Destruction caused by a May 22, 1960 tsunami in the Waiakea area of Hilo, Hawaii. The waves caused 61 deaths and $23 million in damage in the area. Photo: US Navy.

State Tsunami Program
State of Oregon

EDUCATION

Evacuation & Educational Signage:

Oregon was the first state on the mainland to install a system of tsunami evacuation and hazard education signs. The Oregon Department of Geology and Mineral Industries (DOGAMI) also pioneered tsunami interpretive and safe destination signs. The sign program raised public awareness to a very large degree. Working with Oregon Emergency Management (OEM), the two agencies are assisting schools and state parks in a program to develop good evacuation routes and sign locations.

Public Information Products:

A whole catalog of public information products were developed by DOGAMI (see Multi-State Project Section of this report) including heat sensitive coffee mugs that demonstrate how to survive a tsunami, magnets, place mats, bookmarks and other things that tell what to do to survive. The products have been distributed in several states in the National Program, and to others such as British Columbia, Canada.

Tsunami public education sign posted in Newport, Oregon. Photo: Chris Jonientz-Trisler, FEMA.

State Videos:

An excellent video demonstrating the tsunami hazard and tsunami survival is now available. Though made for Grades 4-12, adults will enjoy and learn something from "Tsunami! Surviving The Killer Waves." A general public tsunami video exists also.

Curriculum Materials:

The video, "A Japanese Folktale," for Grades K-3 is a charming, artistically rendered tale from Japan that shares what older tsunami survivors know firsthand – go uphill away from the sea when the signs begin. "Tsunami! Surviving The Killer Waves" is described above. Curricula was developed and teacher workshops have been held to demonstrate it.

Tourist Information:
State agencies are beginning to work with lodging facilities in Oregon to develop evacuation routes and provide brochures to tourist to inform them what to do. Other potential new projects include: working with rental car agencies to place tsunami education material in cars; working with DOT to add this information to the Oregon State Map; and working with AAA to add similar information to their newsletter and tour books.

State and Local Officials Information:
The State agencies have worked to educate government officials with their expertise through several avenues including the Oregon Seismic Safety Policy Advisory Committee.

Public Education:
Along with the continued distribution of public education products and installation of signs, the agencies are planning to develop partnerships with bookstores, libraries, and public and cable TV to disseminate tsunami videos.

TOOLS FOR EMERGENCY MANAGERS

Community Needs Assessments and Surveys:
Both OEM and DOGAMI have been involved in numerous needs assessments with such groups as schools and communities. They have met with the target groups to discuss needs and run surveys to define a baseline from which to proceed. A special study by DOGAMI in 1995 pointed out that most of the critical facilities in many coastal communities are at risk from severe ground shaking and/or tsunami inundation.

Inundation Maps:
Inundation maps were made a few years ago and are being refined through the Tsunami Inundation Mapping Effort (TIME) Center in Newport, Oregon. The entire Oregon Coast is now mapped and selected areas have been and will be mapped in greater detail.

Evacuation Routes and Brochures:
Evacuation routes have been and are being developed in several communities with accompanying brochures designating routes and safe areas.

Warning Programs:
Warning programs have been and are being developed in communities. One of the first was in Cannon Beach which has had a chance to test it a couple of times.

BUILDING AND LAND USE GUIDANCE

Zoning Regulations and Land Use Guides for Tsunami:
Early inundation mapping was linked to legislation requiring new critical facilities such as schools to be built outside the tsunami inundation zone.

INFORMATION EXCHANGE AND COORDINATION

Coastal Jurisdiction Contact:

OEM and DOGAMI have had a lot of interaction with local jurisdictions on tsunami issues and have assisted them in improving their planning and mitigation activities.

Tsunami deposit overlays black fire pits of early Native Americans on the Oregon Coast. Photo: Wendy Grant, USGS.

Meetings Between Different Disciplines:

DOGAMI and OEM often meet with a variety of players to accomplish goals specific to them.

Tsunami Workshops:

OEM brought many of the coastal jurisdictions together for a regional workshop.

Web Page Development:

A State tsunami web page has been developed.

LONG-TERM TSUNAMI MITIGATION

State/Local Tsunami Work Groups:

OEM used a regional workshop to invite anyone interested in working on issues developed at the workshop to join a State/Local Tsunami Work Group. Several interested parties joined project teams.

State Tsunami Mitigation Planning:

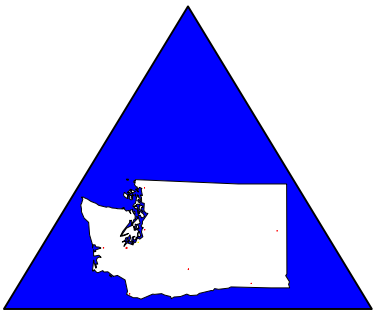
The State has worked legislation and worked with locals on mitigation planning in many areas.

For More Information, Contact:

Mark Darienzo **(503) 378-2911 ext 237**
Oregon Emergency Management **mdarien@oem.state.or.us**

Or

Angie Karel **(503) 731-4100 ext 214**
Oregon Dept. of Geology and Mineral Industries **angie.karel@state.or.us**



State Tsunami Program
State of Washington

EDUCATION

Evacuation & Educational Signage:
Signage was based on Oregon's model. The State and locals worked together to plan and install evacuation and hazard signs. The completed inundation maps will serve as a check on the obvious locations.

Public Information Products:
Washington ordered and distributed many of the products developed by Oregon for public information on tsunamis.

State Videos:
The State uses a locally broadcast special news hour titled "On Fragile Ground" that describes the hazards of tsunamis, earthquakes and volcanoes. Local scientists and residents are interviewed. The hour is very well organized and keeps interest despite the length of the video and substantial amount of earth science material covered.

Curriculum Materials:
These materials are under development.

Library-type Materials Inventory:
The Department of Natural Resources (DNR), Geology Division, has developed two excellent inventories of tsunami materials. One product, The Tsunami Annotated Bibliography, lists mostly Northwest publications and appeals to primarily scientists and others dealing with the application of science of tsunamis. The other product has been recently revised to appeal to additional audiences of far less technical background. This product, *TsuInfo Alert* newsletter, contains updated scientific and emergency management type of materials and also includes book reviews and short articles.

Tourist Information:
Tsunami interpretive signs have been installed in 29 locations along the coast and Island County. Island County Beach Watchers are doing tsunami talks on the beaches and have partnered with the Washington State Department of Transportation Ferry System to provide tsunami/earthquake talks to passengers on the ferries.

State and Local Officials Information:
The *TsuInfo Alert* newsletter is being used to educate government officials, especially as revised.

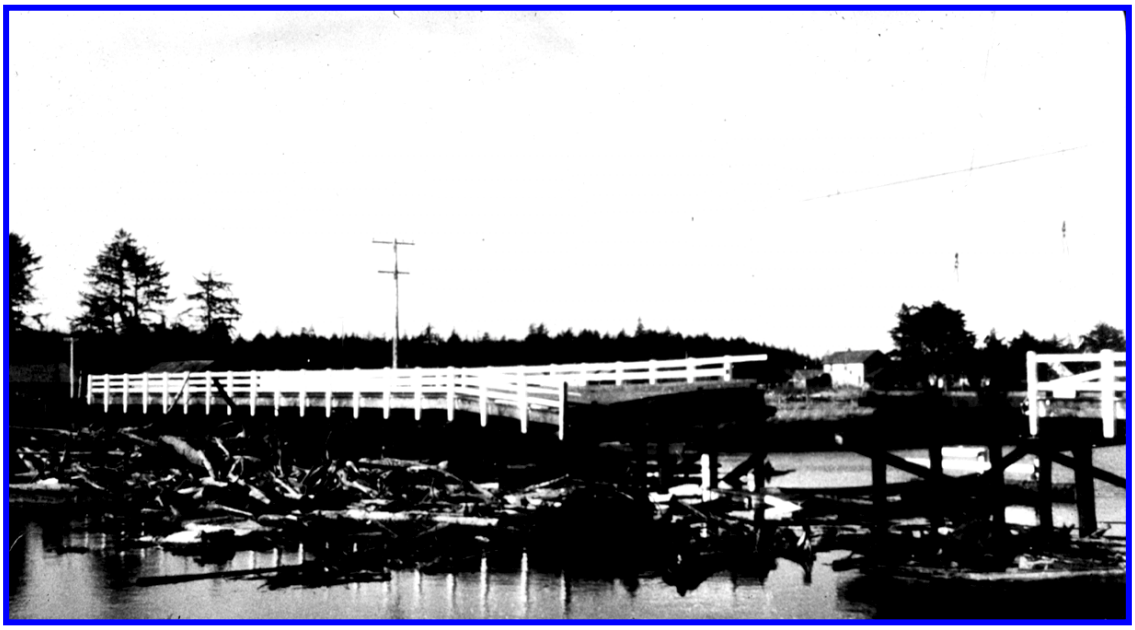
Public Education:

Tsunami Awareness Month is being planned as are ferry wall maps with tsunami information.

TOOLS FOR EMERGENCY MANAGERS

Community Needs Assessments and Surveys:

The State began their Tsunami Program by bringing in county officials to develop a list of prioritized needs that they then coordinate available funding to.



Washington State Highway 109 bridge over the Copalis River damaged during the 1964 Tsunami. Photo: Hogan and Whipple, USACE.

Inundation Maps:

Inundation maps are being modeled at the Tsunami Inundation Mapping Effort (TIME) Center in Newport, Oregon and drafted by DNR staff. Counties are planning major public education efforts with the arrival of the maps.

Evacuation Routes and Brochures:

Evacuation routes have been and are being developed in several communities and evacuation brochures will be completed when inundation maps are finished.

Warning Programs:

Warning programs have been and are being developed in communities. County and tribal officials are planning with the National Weather Service to provide enhanced coverage for Washington and to use NOAA Weather Radio more substantially for tsunami warnings among others.

INFORMATION EXCHANGE AND COORDINATION

Coastal Jurisdiction Contact:
A lot of contact with local jurisdictions has occurred on outer coast and inland coast locations. The State Program is heavily driven by the locals and their needs.

Meetings Between Different Disciplines:
Groups effected by tsunami issues are welcome to work together on tsunami issues.

Tsunami Workshops:
Many community and county workshops have been held which generated interest and enthusiasm over addressing tsunami issues. A three state conference on coastal earthquake issues will bring together local officials and planners from Alaska, Oregon and Washington to learn from each other.

Web Page Development:
A State tsunami web page has been developed and the State has assisted several counties in developing their own.

LONG-TERM TSUNAMI MITIGATION

State/Local Tsunami Work Groups:
This state has a strong State/Local Tsunami Work Group that started in 1997 based on local needs. It is made up of all coastal counties, Federal and State emergency managers, geologists, Department of Transportation, NOAA Weather Service, and recently welcomed tribal leaders into the group. The group is looking to involve local businesses and has recently partnered with a multistate private/public earthquake consortium, the Cascadia Region Earthquake Workgroup (CREW), in a coastal project.

State Tsunami Mitigation Planning:
The State has promoted legislation and worked with locals on mitigation planning in many areas.

For More Information, Contact:
George Crawford **(253) 512-7067**
Washington Emergency Management Division **g.crawford@emd.wa.gov**

or

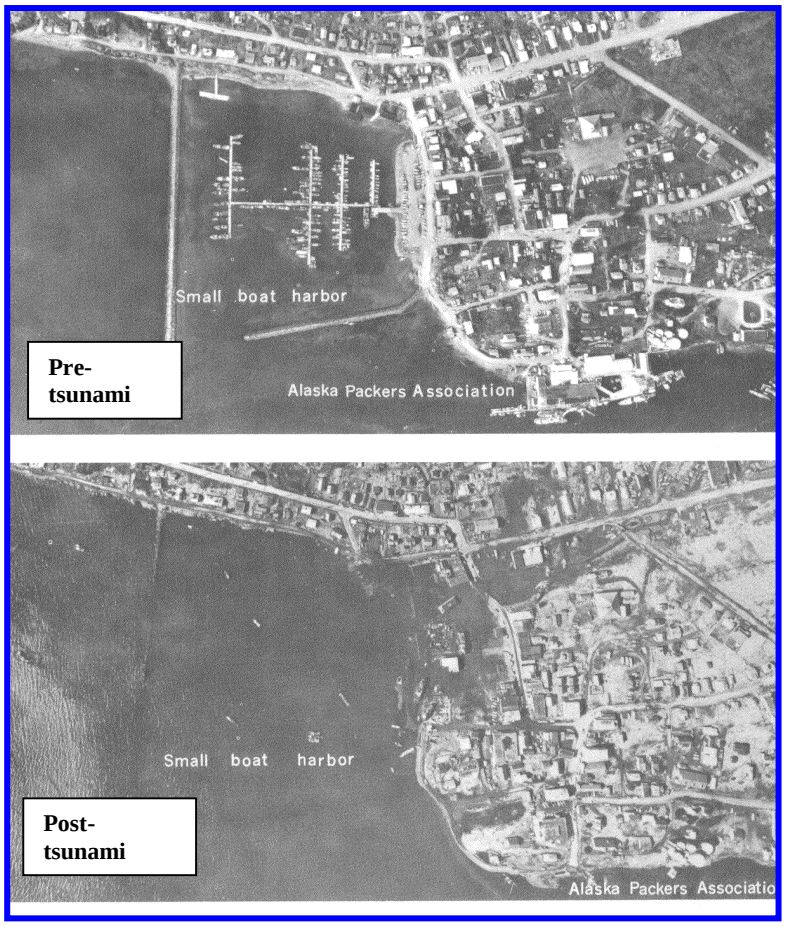
Timothy Walsh **(360) 902-1432**
Washington Department of Natural Resources **tim.walsh@wadnr.gov**

PART 2

CASE STUDIES

Inundation Mapping Partnership
State of Alaska

In 1964, Kodiak was just one of many coastal communities in Alaska that was hard hit by the magnitude 9.2 earthquake and series of tsunamis that originated nearby. At least 10 waves were observed to rush inland for up to 600 feet, destroying most of the fishing boats and more than 200 structures throughout a several block area of downtown. Luckily only two residents were drowned in Kodiak.



Aerial view of downtown Kodiak. Top: Pre-tsunami (Photo: Bureau of Land Management, 1962). Bottom: Post-tsunami (Photo: Air Photo Tech, Anchorage, 1964).

In 1998, a Blue Ribbon Panel was established to initiate a tsunami inundation mapping process in Alaska. They met on March 23-24, 1998, in Kodiak, Alaska to conduct site visits and exploratory meetings. The panel included members from the Alaska Division of Emergency Services; the Geophysical Institute, University of Alaska Fairbanks; the Alaska Division of Geological & Geophysical Surveys; the Federal Emergency Management Agency; the National Oceanic and Atmospheric Administration / Center for Tsunami Inundation Mapping Efforts; and Kodiak Island Borough's Community Development Department. Kodiak was previously identified as a high-priority region for inundation mapping based on its population, commercial resources, and vulnerability to tsunamis demonstrated by the March 27, 1964 event.

The Panel was successful in piloting the tsunami inundation mapping process in Alaska. A key to their success was their involvement with the community leaders. They met with and received support and/or commitments from the mayors of Kodiak Island Borough and the City of Kodiak, as well as the Commander of the US Coast Guard Base on Kodiak Island, the American Red Cross Disaster Response Planner for Alaska, and other community leaders. Subsequently, the inundation mapping

project for three sites on Kodiak Island has been funded with monies from the NTHMP and the Alaska Science and Technology Foundation and is expected to be completed in October, 1998. For future projects the Panel will continue to be a critical element of the State/Federal partnership in providing methods to assist tsunami hazard assessment and mitigation efforts in threatened Alaskan communities. The composition of the Panel will be tailored to meet the needs of each community.

This successful process has generated substantial interest and anticipated support from other Alaskan coastal communities that will compete for future inundation mapping projects. The Blue Ribbon Panel is a catalyst for tsunami awareness in communities at risk in Alaska and in the long run that translates to lives saved.

Alaska's Blue Ribbon Panel at work with local officials in Kodiak. Photo: Chris Jonientz-Trisler, FEMA.

Process Checklist

- ❑ Gather range of experts needed
- ❑ Consult locals prior to map decisions
- ❑ Assess, prioritize risk areas to map based on expert and local info
- ❑ Show locals uses and limitations of maps to guide proper use

Strategic Planning Areas

This program addresses elements of the Strategic Implementation Plan for Tsunami Mitigation Projects such as:

- Tools for Emergency Managers – inundation maps and education in their use.

Building a Tsunami Resistant Community

The State of Alaska is helping locals build toward "tsunami resistant communities" by making a range of experts on various mapping components available to partner with local communities and make mapping decisions jointly based on solid technology and local knowledge of issues.

Expected or Demonstrated Success

- **The partnership mapping process has resulted in community ownership of the risk.**
- **The maps will save lives** during future tsunamis as the community becomes educated.
- **The maps are a catalyst** for other tsunami planning and mitigation efforts.

For More Information, Contact:

Gary Brown **(907) 428-7036**
Alaska Division of Emergency Services **gary_brown@ak-prepared.com**

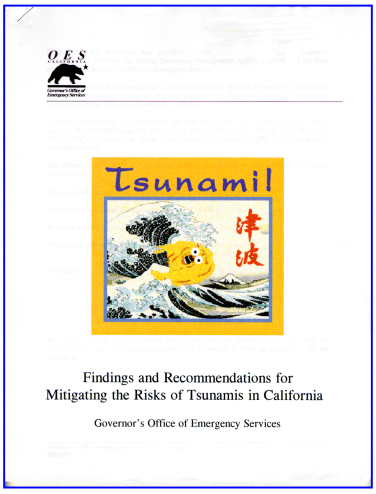
Building a Constituency for Tsunami Hazard Mitigation

State of California

The Governor's Office of Emergency Services convened a workshop of federal, state and local officials responsible for emergency and coastal zone management on May 28 – 29, 1997. The goal of the workshop was the development of a consensus strategic plan for tsunami hazard mitigation for the state of California.

The Workshop had the following objectives:

- Educate participants on the tsunami threat and regions at risk of inundation
- Review activities of the Alaska West Coast Tsunami Warning Center and identify gaps in notification procedures, technical assistance and resource needs of locals
- Review the limits of the tsunami watch/warning procedures for local tsunamis
- Identify priority actions to promote and promulgate tsunami hazard mitigation



The Workshop resulted in a report, "Findings and Recommendations for Mitigating the Risks of Tsunamis in California" that now serves as California's strategic plan for tsunami hazard mitigation. The two highest priority activities identified in the plan (provide high risk communities with state-of-the-art inundation projections, and develop guidance for local governments on how to interpret the projections and use them for evacuation planning) are being implemented currently.

Another important result of the workshop is that it built a longer-term constituency for tsunami hazard mitigation. The coastal county emergency managers who participated in the workshop are now part of the state effort to develop and use inundation maps for local evacuation planning. They currently serve on a state steering committee overseeing the development of local government guidance. State agencies with a stake in tsunami mitigation, including the Coastal Commission, Seismic Safety Commission, Department of Mines and Geology, State Lands Commission, and the State Department of Parks and Recreation are now coordinating their planning efforts.

As a result of priorities set at the workshop, OES Coastal and Southern Regions now include tsunami, along with erosion, storm surge and winter storm flooding in their GIS mapping of coastal risk. Funding has been committed from MAP 50 (NEHRP matched by General Funds) to expand the area covered by modeling tsunami inundation.

On the basis of the knowledge gained through their participation in the steering committee, Los Angeles County has initiated the development of a local tsunami

response plan. With the assistance of coastal counties, OES will complete a local government planning guidance to address the use of inundation projections, evacuation procedures and additional guidance for communication of tsunami watches and warnings. OES is providing real-time paging notification to coastal counties of receipt of tsunami watches and warnings issued by the Alaska West Coast Tsunami Warning Center.

Process Checklist

- ❑ Convene a workshop inviting affected federal, state and local officials to develop a consensus strategy for reducing tsunami risk in a coordinated manner.
- ❑ Set workshop objectives to include educating the community on the risk, reviewing specific activities of interest and their limits, and identifying priority actions to promote tsunami risk reduction.
- ❑ Allow participants to buy into the strategy by letting them set the priorities, develop the recommendations for action, and oversee implementation of the strategy.
- ❑ Incorporate tsunami risk into other coastal risk planning if possible for efficiency.

Strategic Planning Areas

This program addresses elements of the Strategic Implementation Plan for Tsunami Mitigation Projects such as:

- Education – information provided to officials allows them to plan and prioritize.
- Information Exchange and Coordination – coastal representatives can learn from each other about existing tsunami risk reduction activities and can coordinate development of new ones that better fit their needs
- Long-Term Tsunami Mitigation – constituencies can make tsunami hazard reduction a part of local, regional and state hazard mitigation programs
- Implementation – a constituency of activists can be a power for motivating officials and citizens to reduce risk, can encourage local action, and uses limited resources efficiently.

Building a Tsunami Resistant Community

California State is helping locals build toward "tsunami resistant communities" by encouraging a team approach to a common coastal hazard and ensuring effective use of scarce resources through coordination and prioritization.

Expected or Demonstrated Success

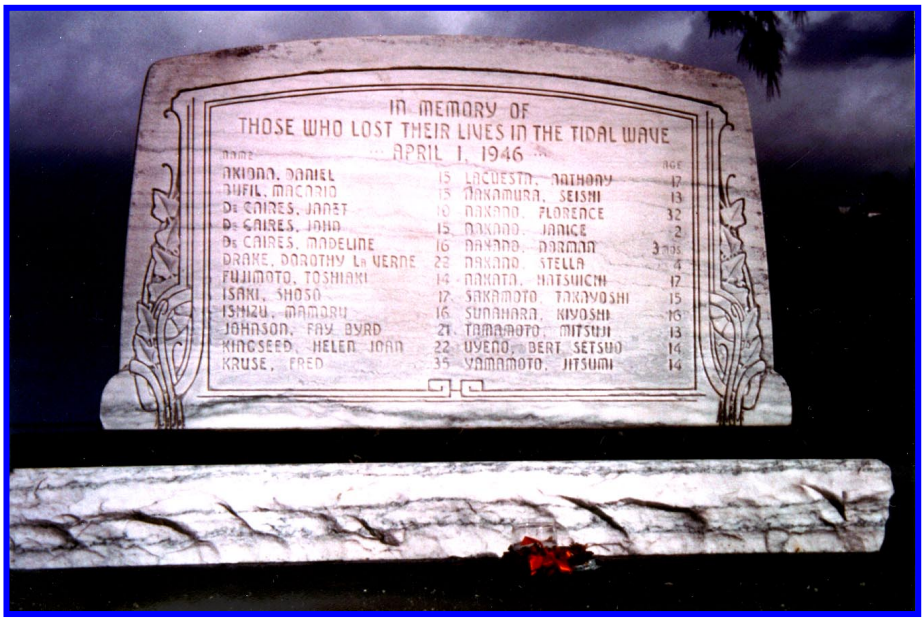
- **The tsunami hazard constituency building has resulted in ownership of the tsunami risk in participating communities.**
- **The constituency will save lives through effective priority planning.**
- **The constituency is a catalyst for long-term tsunami hazard reduction activities in participating communities.**

For More Information, Contact:

Rich Eisner, Regional Administrator **(510) 286-0895**
California Governor's Office of Emergency Services **rich_eisner@oes.ca.gov**

Tsunami Working Group
State of Hawaii

Hawaii is located mid-ocean, serving as a grand central station for trains of tsunami waves originating from anywhere around the Pacific Rim, and has suffered repeated historical loss of lives and property. These waves travel rapidly to strike communities and require specialized personnel and systematic pre- and post disaster planning. By Hawaii law, State, City and County Civil Defense (CD) is structured as part of a unified emergency management system. For decades, this system has comprehensively reviewed and coordinated all hazards emergency planning, including tsunamis. In the past decade, the Tsunami Working Group (TWG) grew out of this process. In 1998, Hawaii CD continued to support an existing TWG made up of representatives from State and County CD, the Pacific Tsunami Warning Center (PTWC), the U.S. Geological Survey, and local tsunami scientists who meet quarterly. CD provides some logistics including airfare coupons from funding provided by the National Tsunami Hazard Mitigation Program.



Memorial at Laupahoehoe, Hawaii, for 24 children and teachers who were killed by a 1946 tsunami. Photo: Chris Jonientz-Trisler, FEMA.

Process Checklist

- ❑ Include representatives from all levels of pre- and post-disaster planning as a system solution
- ❑ Include scientific agencies and local experts so that technical information is used correctly
- ❑ Meet regularly to improve and update usability of information and procedures

Strategic Planning Areas

This program addresses elements of the Strategic Implementation Plan for Tsunami Mitigation Projects such as:

- Tools for Emergency Managers – technical information is interpreted for use in warnings. This group also provides input to PTWC for warning policy and procedure after reviewing events.

Building a Tsunami Resistant Community

Hawaii State and its counties are building toward a "tsunami resistant community" by understanding the nature of the tsunami hazard, disseminating information about the tsunami hazard, and institutionalizing planning for future tsunami disasters.

Expected or Demonstrated Success

- **Timely warnings have saved lives** by moving communities out of harm's way.
- **The expert and user collaboration to update policy and procedures improves existing warning tools** for all levels of emergency managers.
- **The Work Group's improvement of the warning system impacts warning procedure issues for other Pacific-wide areas**, including those in the National Program that are the responsibility of the Alaska Tsunami Warning System (ATWC).

For More Information, Contact:

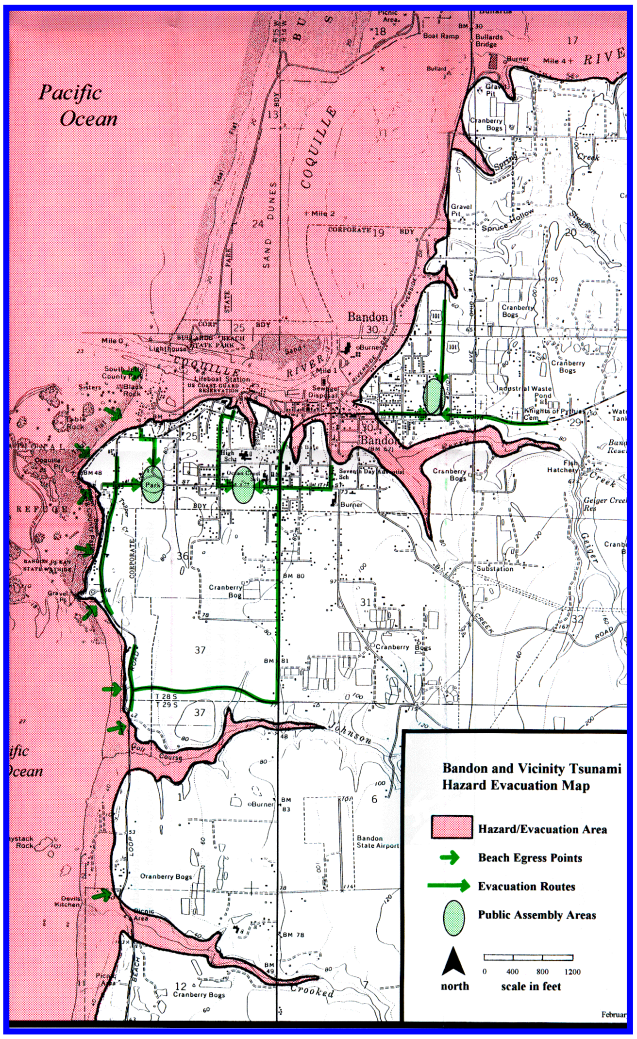
Brian Yanagi, Earthquake Program Manager (808) 733-4300
Hawaii Civil Defense byanagi@scd.state.hi.us

Warning status boards located in the County Civil Defense Emergency Operations Center on the Island of Hawaii. The boards show local use of information provided by the Tsunami Warning Center. Photo: Chris Jonientz-Trisler, FEMA.

Tsunami Evacuation Brochure
State of Oregon

Oregon Emergency Management (OEM) and the Oregon Department of Geology and Mineral Industries (DOGAMI) met with Oregon communities along the Oregon coast to discuss the development of tsunami evacuation brochures. They met with 16 communities from all seven coastal counties. Several agreements were signed to date with cities and counties to produce, print, and distribute the brochures. Contact was made in one of two ways with communities. In some cases the county emergency manager was approached and asked to set up a community meeting. In other cases, the communities were contacted directly and the county was invited to participate.

At the meeting, discussion included the tsunami threat and the process to produce and pay for brochures. Brochure development was based upon content criteria that included a street map base, an evacuation line that delineates safe zones, and best evacuation routes and sites. However, the community held a major role in production of the brochure: where to place the evacuation line, where to locate evacuation routes and sites, and what text, if any, to include in the brochure. The widespread interest in developing and distributing brochures in many coastal communities will insure that residents and visitors are aware of what to do and where to go when a tsunami is expected.



Tsunami Hazard Evacuation map for Bandon, Oregon area.

Process Checklist

- ❑ Invite counties and communities to meet to explore tsunami evacuation brochure development.
- ❑ At the meeting, update the community on the tsunami risk and discuss the process to produce and pay for the brochures.
- ❑ Discuss the criteria required for the brochure such as a street map, evacuation line, safe zones, evacuation routes and sites.
- ❑ Allow the community to make decisions on where the evacuation line, routes and sites should go while working in conjunction with expert geologic advise on their choices.

Strategic Planning Areas

This program addresses elements of the Strategic Implementation Plan for Tsunami Mitigation Projects such as:

- Tools for Emergency Managers – the brochure process interprets technical information about tsunami inundation into applicable information to save lives.
- Education – the brochures provide information to the public on where to go if there is a tsunami threat.

Building a Tsunami Resistant Community

Oregon State is helping locals build toward "tsunami resistant communities" by helping them understand the serious tsunami risk and plan for saving lives through appropriate evacuation.

Expected or Demonstrated Success

- **The brochure has resulted in ownership of the tsunami risk in participating communities.**
- **The brochure will save lives by providing appropriate evacuation information to citizens and visitors.**
- **The brochure is a catalyst for other tsunami hazard reduction activities in participating communities.**

For More Information, Contact:

Mark Darienzo, Earthquake Program Manager **(503) 378-2911 extension 237**
Oregon Emergency Management **mdarien@oem.state.or.us**

Tsunami Warning & Evacuation Sign Program

State of Washington

In response to a variety of community reactions to the 1994 Pacific-wide tsunami warning, the State took the lead in establishing a consistent message and appropriate reaction to future tsunami warnings in Washington. In 1997, State Emergency Management Division (EMD) invited coastal county emergency managers to work as partners in a State and Local Tsunami Program Work Group. The counties drafted and prioritized their needs. The priority need was to make the tsunami hazard visible to community officials and residents. Signs developed by the Oregon Department of Geology and Mineral Industries (DOGAMI) and installed in Oregon were shown to the group. In Oregon the signs were bringing attention to the hazard, educating residents and visitors as to appropriate actions to take during a tsunami warning, and hopefully spurring plans and actions for long-term reduction of loss of life and property.

Washington officials wanted signs installed immediately rather than wait for completion of tsunami inundation maps due out in a year or two. Sign placement was decided based upon common sense and the best current information available. Sign locations could then be revised and announced if new maps indicated some changes in any given tsunami evacuation route.

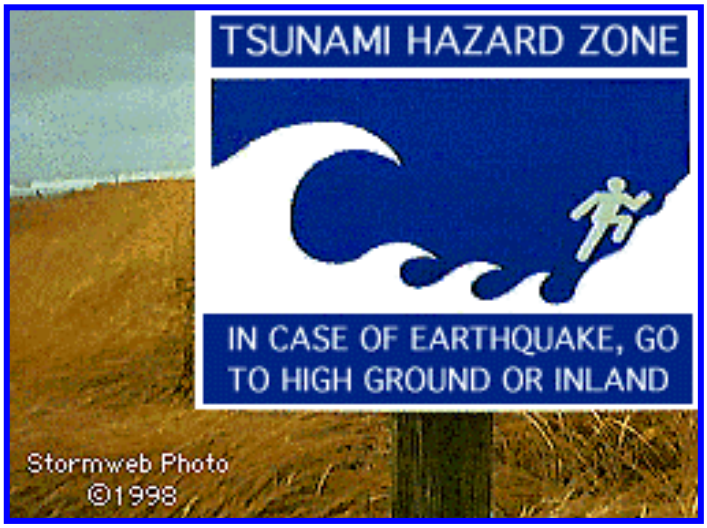


Photo: John Dominoski, Stormweb

The State Department of Transportation collaborated on the signage project. Each county emergency manager was responsible for deciding sensible evacuation routes, and determining the location and number of signs needed. Costs of material and labor and any in-kind contributions were applied to the number of signs in order to determine the necessary resources. A factor was included to cover replacement signs based upon experience with other types of road signs. Templates and specification of the signs were requested from the Department of Oregon Geology and Mineral Industries for two reasons: to ensure that signage was consistent across state borders, and to minimize development costs. Each county worked with the County Public Works for positioning of evacuation signs on county roads. They then drove evacuation routes with local Department of Transportation officials to determine positioning of signs on state highways. Tsunami informational brochures were distributed in counties prior to the installation of the interpretive signs. Later in the program, Parks and Tribes were invited to participate, and have reciprocated with interest.

The blue and white tsunami signs have become collector items. To reduce the theft rate, anti-theft bolts have been installed with a warning and penalty statement on the back of each sign. The State is also using educational material that mimics the design of the tsunami signs as a way to reduce theft.

Process Checklist

- ❑ Involve county, state and tribal emergency managers, parks, Department of Transportation, state geological survey and other agencies to provide information relevant to program.
- ❑ Explore existing and potential resources for program including in-kind contributions.
- ❑ Use best available information including common sense and inundation maps if they exist.
- ❑ Provide information through brochures and meetings to others impacted by sign program.

Strategic Planning Areas

This program addresses elements of the Strategic Implementation Plan for Tsunami Mitigation Projects such as:

- Education — signs alert the community to the tsunami risk.
- Tools for Emergency Managers — signs are a component of the evacuation system.

Building a Tsunami Resistant Community

Washington State coastal counties are building toward a "tsunami resistant community" by disseminating information about the tsunami hazard, and institutionalizing planning for a tsunami disaster.

Photo: John Dominoski, Stormweb

Expected or Demonstrated Success

- **Signs are expected to save lives** by raising community awareness before a tsunami and by notifying people of appropriate evacuation routes for use during a tsunami warning.
- **Signs have already demonstrated their use as a tool for raising pre-event awareness**. Signs have generated media attention that educates the communities at a broader level than any other mitigation tool. The signage program has also served to bring longer-term tsunami mitigation issues to the table for discussion.
- **Signs are encouraging local sponsorship of tsunami mitigation** programs.
- **A state sign program has been a cost-effective way of disseminating a consistent message** about the potential impact areas and how to react to tsunami warnings among coastal communities. The signs used by Washington State were developed in Oregon and are to be installed soon in Alaska and perhaps California as well. (Hawaii has had a signage system in use for many years). Similar signage among states extends a consistent message to the transient tourist population that travels across state boundaries and is less aware of tsunami hazards than coastal residents.

For More Information, Contact:

George Crawford, Earthquake Program Manager **(253) 512-7067**
Washington Emergency Management Division **g.crawford@emd.wa.gov**

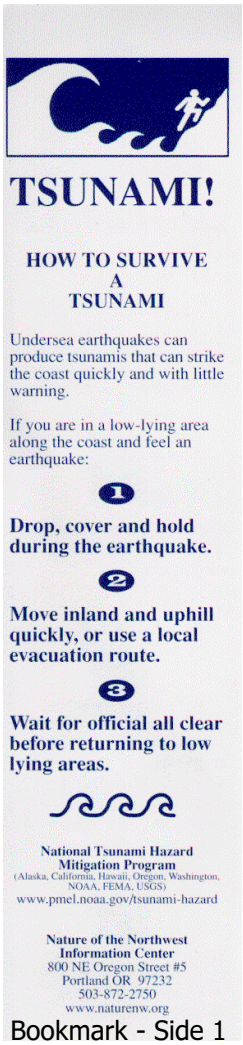
PART 3

MULTI-STATE PROJECTS

Multi-State Projects

In 1997, the five States, Alaska, California, Hawaii, Oregon, and Washington, collectively decided to set up a special pot from their mitigation monies to fund projects that would benefit more than one State, including States and Territories other than the five Program States. The Tsunami Hazard Mitigation Committee, which includes members from the five States and FEMA, selects the projects to be developed from proposals submitted by Committee members. So far, the Committee has approved five multi-State projects. They are: Tsunami Public Education Materials, *TsuInfo Alert* Newsletter, *Tsunami Survival - Lessons from Chile* book, Tsunami Warning System and Procedures Guidance, and Local Tsunami Hazard Mitigation Guidance for Buildings and Land Use.

TSUNAMI PUBLIC EDUCATION MATERIALS



Bookmark - Side 1

Bookmark - Side 2

The State of Oregon, Department of Geology and Mineral Industries (DOGAMI) took the lead in developing this project. They created various public education products and then developed a catalog to order from. Each State received a complimentary package of all the products as part of the project. Additional quantities can be ordered from DOGAMI. The educational products they developed included: a bookmark, brochure, family disaster card, hazard zone decal, heat-sensitive tsunami mug, magnets, posters, stickers, tent card, trivia card, trivia coloring sheet, tsunami hazard zone and evacuation signs, and tsunami videos.

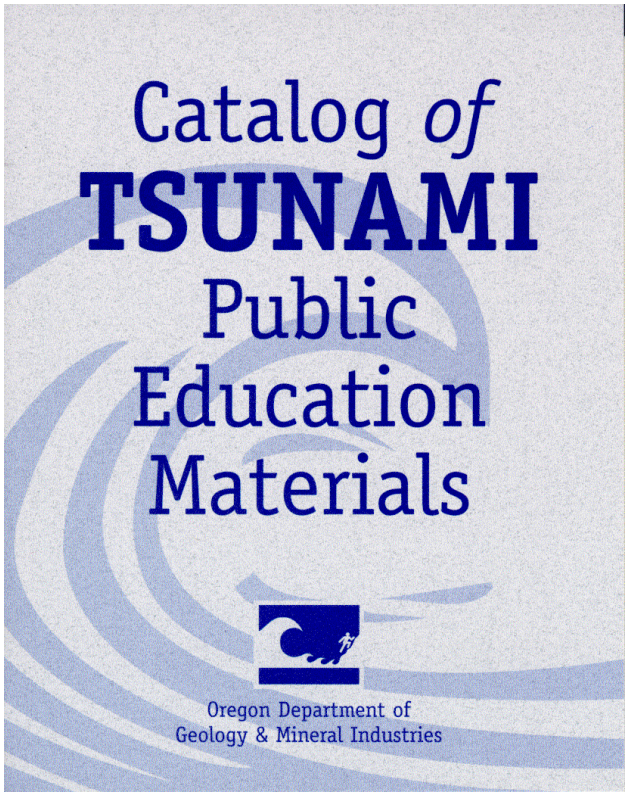
Strategic Planning Areas

This project addresses elements of the Strategic Implementation Plan for Tsunami Mitigation Projects such as:

- Education - Information for the general public; information for tourists, seasonal workers, and transients who occasionally visit coastal areas; and curriculum materials for schools.

Building a Tsunami Resistant Community

This project is helping build toward "tsunami resistant communities" by helping the public understand the nature of the tsunami hazard, and disseminating information about it.



Expected or Demonstrated Success

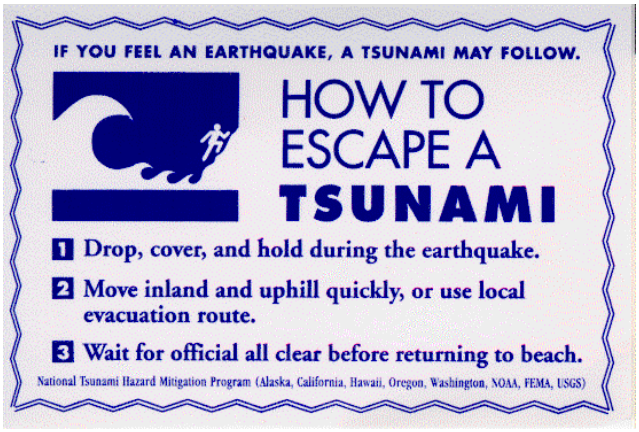
- The people are becoming more aware of the hazard.
- The products will save lives by ensuring people know what to do when the ground shakes on the coast.

For More Information, Contact:

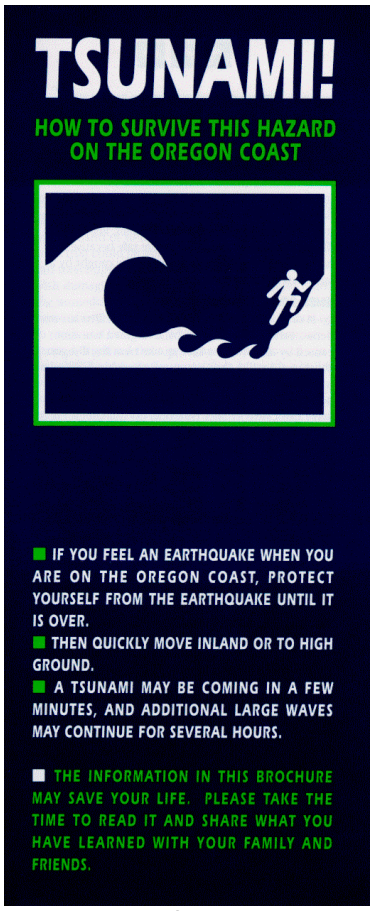
Angie Karel (503) 731-4100
OR Dept. of Geology & Mineral Industries

Hazard Zone Decal

Tsunami Heat-Sensitive Mug

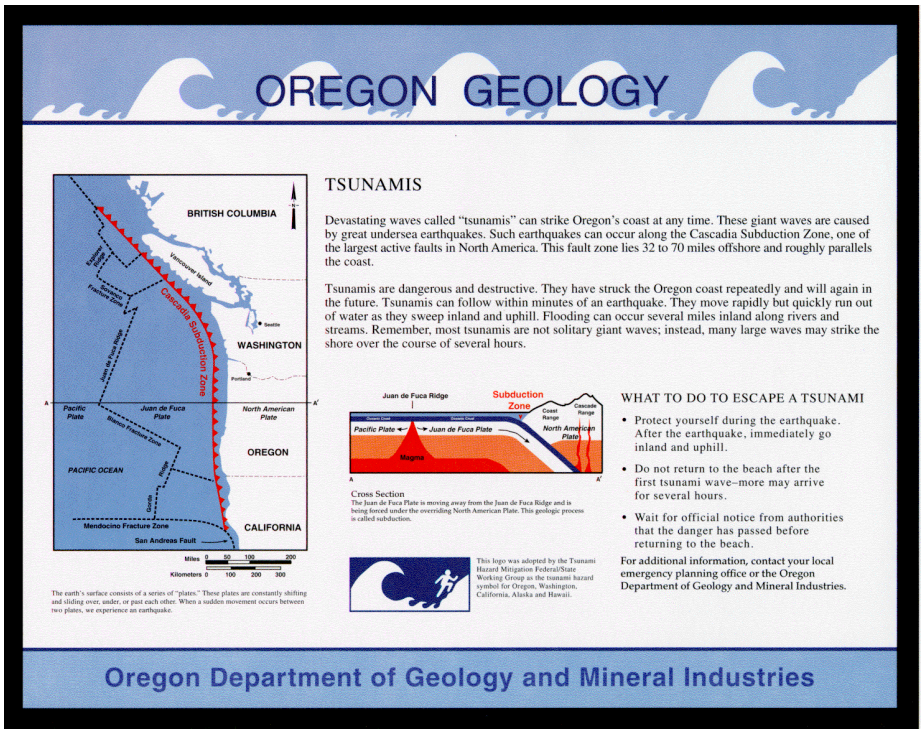


Tsunami Family Disaster Card, Magnet, Sticker, and Tent-Card



Tsunami Brochure

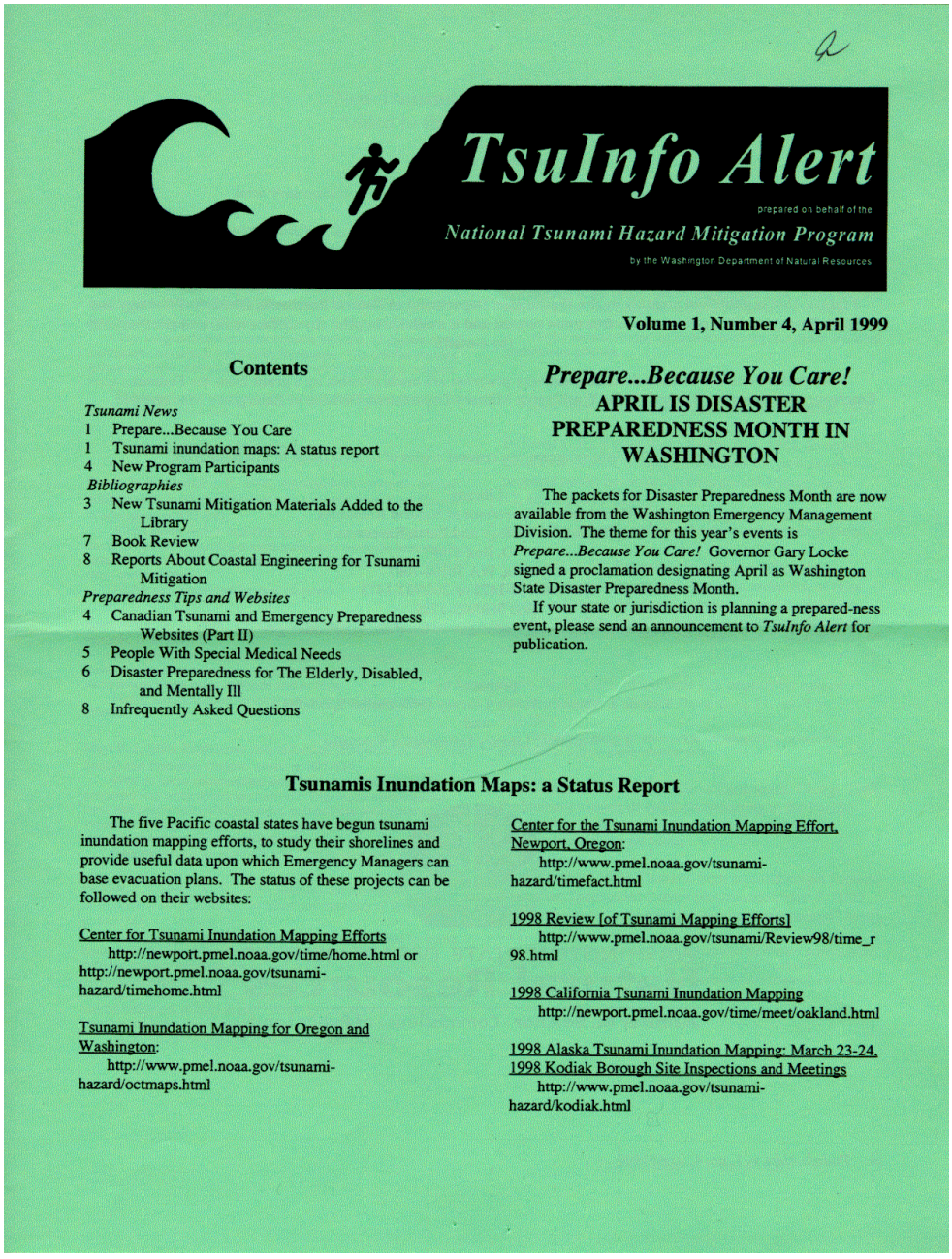
Tsunami Trivia Coloring Sheet



Tsunami Poster

TSUINFO NEWSLETTER

Washington State Department of Natural Resources (DNR), Division of Geology and Earth Resources, took the lead in developing this project. They created a Tsunami Information System to provide current tsunami and research information to local emergency managers, local officials, and others involved in tsunami mitigation efforts. DNR began the project by assembling a database of citations about tsunami hazards and mitigation in an effort to organize scattered information. The database will be available on disk, in print, and on the Tsunami website. The next step involved informing the local communities of new or newly identified materials available to help them in mitigating the tsunami hazard.



TsuInfo Alert

prepared on behalf of the National Tsunami Hazard Mitigation Program by the Washington Department of Natural Resources

Volume 1, Number 4, April 1999

Contents

Prepare...Because You Care!
APRIL IS DISASTER PREPAREDNESS MONTH IN WASHINGTON

The packets for Disaster Preparedness Month are now available from the Washington Emergency Management Division. The theme for this year's events is *Prepare...Because You Care!* Governor Gary Locke signed a proclamation designating April as Washington State Disaster Preparedness Month.

If your state or jurisdiction is planning a prepared-ness event, please send an announcement to *TsuInfo Alert* for publication.

Tsunamis Inundation Maps: a Status Report

The five Pacific coastal states have begun tsunami inundation mapping efforts, to study their shorelines and provide useful data upon which Emergency Managers can base evacuation plans. The status of these projects can be followed on their websites:

Center for Tsunami Inundation Mapping Efforts
http://newport.pmel.noaa.gov/time/home.html or http://newport.pmel.noaa.gov/tsunami-hazard/timehome.html

Tsunami Inundation Mapping for Oregon and Washington:
http://www.pmel.noaa.gov/tsunami-hazard/octmaps.html

Center for the Tsunami Inundation Mapping Effort, Newport, Oregon:
http://www.pmel.noaa.gov/tsunami-hazard/timefact.html

1998 Review [of Tsunami Mapping Efforts]
http://www.pmel.noaa.gov/tsunami/Review98/time_r98.html

1998 California Tsunami Inundation Mapping
http://newport.pmel.noaa.gov/time/meet/oakland.html

1998 Alaska Tsunami Inundation Mapping: March 23-24, 1998 Kodiak Borough Site Inspections and Meetings
http://www.pmel.noaa.gov/tsunami-hazard/kodiak.html

DNR accomplished this by creating a newsletter which they send to tsunami communities each month to alert them of this material. The communities can request hard copies of any report identified in the newsletter at no charge. This effort makes it easier for remote coastal towns to first, be aware of the information available, and second, makes it easier for them to access it. The Tsunami Hazard Mitigation Committee determines who is eligible for this service.

Strategic Planning Areas

This project addresses elements of the Strategic Implementation Plan for Tsunami Mitigation Projects

such as:

- Tools for Emergency Managers - Exchange of information.
- Information Exchange and Coordination - Catalogue existing and new printed and electronic tsunami media. Provide access to tsunami media.

Building a Tsunami Resistant Community

This project is helping build toward "tsunami resistant communities" by disseminating information about the hazard and by exchanging information with many at-risk areas.

Expected or Demonstrated Success

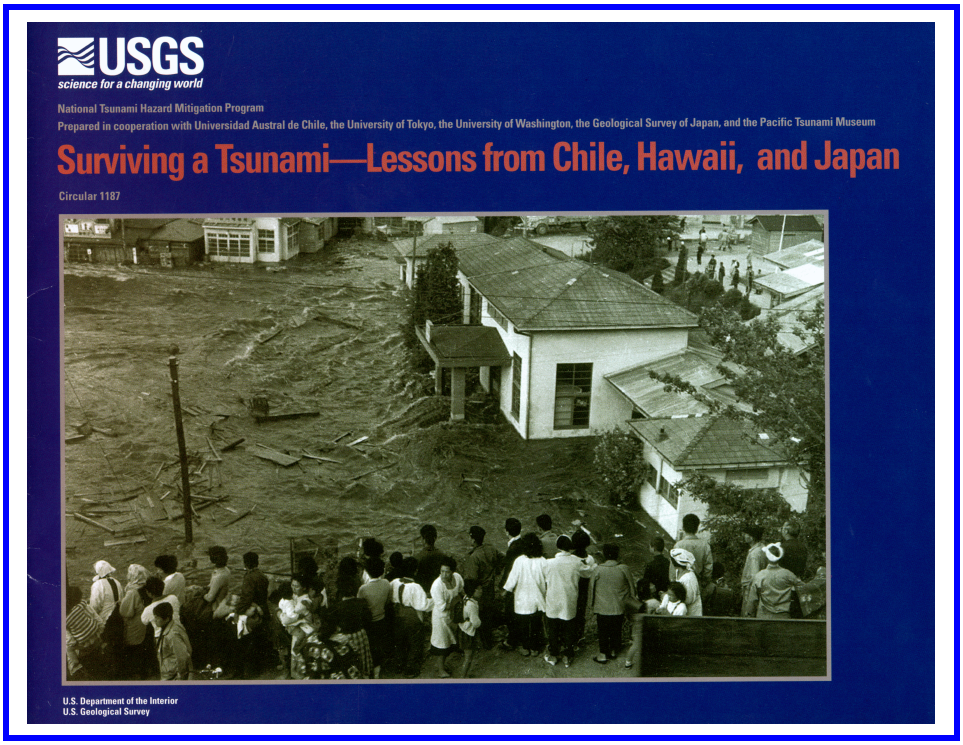
- The newsletter is an information dissemination tool that serves as a resource center of tsunami hazard information.

For More Information, Contact:

Connie Manson, Librarian (360) 902-1472
WA Department of Natural Resources

SURVIVING A TSUNAMI - LESSONS FROM CHILE, HAWAII, AND JAPAN

Washington State Emergency Management Division took the lead in developing this project. Brian Atwater, U.S. Geological Survey scientist, used his research from Chile, Hawaii, and Japan to piece together valuable lessons on tsunamis for people who live in subduction zones. *Surviving a Tsunami—Lessons from Chile, Hawaii, and Japan* was written to teach people who live in areas at risk to tsunamis how to survive. Survivors of the 1960 Great Earthquake and tsunami in Chile provide vivid accounts of what they did during the tsunami that allowed them to stay alive and what some people did that led to their deaths. The lessons are concise and well-demonstrated by photos and diagrams.



Strategic Planning Areas

This project addresses elements of the Strategic Implementation Plan for Tsunami Mitigation Projects such as:

- Education – information for the general public on tsunami hazard.

Building a Tsunami Resistant Community

This project is helping build toward "tsunami resistant communities" by demonstrating to people how to quickly respond in an appropriate manner to immediate danger from tsunamis.

Expected or Demonstrated Success

- The lessons from actual victims of the Chilean tsunami are a real-life lesson teaching readers how to survive in a variety of situations.

For More Information, Contact:

Brian Atwater
US Geological Survey

PROJECTS UNDER DEVELOPMENT

Tsunami Warning Systems and Procedures Guidance

The Oregon Department of Geology and Mineral Industries, in coordination with Oregon Emergency Management, is leading the development of this project. The project staff will begin by inventorying and evaluating all existing tsunami warning systems and procedures in coastal towns of the Committee member States, and of systems in other States and countries, like Japan. The identified systems will be analyzed for their strengths and weaknesses, and recommendations for uniformity will be provided if warranted. The project will culminate in the preparation of a Tsunami Warning Systems and Procedures Guidance for local communities highlighting the results of the research. The report should be completed by the end of 1999.

Local Tsunami Hazard Mitigation Guidance for Buildings and Land Use

California Governor's Office of Emergency Services is leading the developing of this project. This project involves identifying land use policy and practices, and building strategies, approaches, and techniques that would reduce loss of life and property resulting from both near source and distant tsunamis. The project would culminate in the development of a guidance document for local governments outlining approaches most likely to reduce loss of life and damage. The document will include case studies highlighting actual examples of tsunami mitigation. The report should be available by the end of 1999.

APPENDICES

APPENDIX A: Tsunami Survey

"Cascadia Response to October 4, 1994 Kurile Islands Mw 8.3 Earthquake-Induced Tsunami Warning" (presented at American Geophysical Union, Fall 1994 meeting)

C. Jonientz-Trisler, J. Berry (Federal Emergency Management Agency, Region 10, Federal Regional Center, 130 - 228th St. SW, Bothell, WA 98021-9796)

A Mw 8.3 Kurile Islands tsunamigenic earthquake on October 4, 1994 triggered a Pacific-wide tsunami warning. The warning tested the information system and the state of readiness on the Cascadia coast. Responses varied.

Interviews were conducted using a survey questionnaire with province staff for three communities in British Columbia, Canada; with four communities in Washington; four communities in Oregon; and three communities in California. Community populations ranged from about 1,000 up to about 27,000. Elevation range was sea level to over 100 feet. Communities were located on ocean beaches, bays, inlets, and peninsulas.

Tsunami warning information was unclear and unusable to more than a third of communities, and too slow being updated for 71%. Almost 80% were in contact with neighboring communities, but only about 30% had access to a local tsunami expert.

Vulnerability and readiness varied. Almost 80% have critical facilities at risk, and have city tsunami plans. Half of the communities had school tsunami plans. Seventy percent have safe (high) places within a few minutes walking distance. Over a third have landslide hazards, and almost 80% have vulnerable bridges along their evacuation routes. Over half have tsunami warning sirens or fire sirens that would be used in tsunami notification. The average time estimate for safe evacuation was just over two hours, and ranged from 30 minutes to 6 hours. During peak tourist season, this estimate grew in some cases to a factor of 3 or 4 times more. (Some data for British Columbia communities was unknown as of this writing and will be further explored in the near future.)

On October 4, 90% of the communities' decision-makers used wave height data from Hawaii to decide what level of response to make. Twenty one percent began city evacuation; 7% evacuated some facilities (not including port or Coast Guard facilities which responded according to their own authority); and 71% of the communities remained on standby status until the warning was cancelled. Cancellation occurred about 30 minutes before the wave was due on the West Coast when it would have been too late to evacuate for most communities.

Many communities feel the warning system needs improvement. Information should be made more timely and locally usable. Communication must flow two ways: 1) scientists must ask responders what kinds of information systems, formats, and tools that they require for effective response, and 2) responders must ask scientists what limits exist for information and tools that they are basing response decisions upon.

Vulnerability and readiness levels vary among communities. These communities have asked for such tools as local risk identification and expertise, training, and warning equipment.

Responses varied on October 4, 1994. A regional strategy should be developed to provide more consistency in Cascadia coastal communities, including such things as school tsunami plans and drills.

October 4 is a valuable learning exercise for distant tsunamis with several hours warning and for Cascadia tsunamis with immediate response required.

This is preliminary data. The community pool will be increased, county data will be added, and further verification and analysis is planned.

APPENDIX B: Web Page Resources

National Tsunami Hazard Mitigation Program
http://www.pmel.noaa.gov/tsunami-hazard

Pacific Marine Environmental Laboratory, NOAA - Tsunami Program
http://www.pmel.noaa.gov/tsunami

Tsunami Data from the National Geophysical Data Center
http://www.ngdc.noaa.gov/seg/hazard/tsu.html

West Coast and Alaska Tsunami Warning Center Home Page
http://www.alaska.net/~atwc/index.html

International Tsunami Information Center (ITIC)
http://www.shoa.cl/oceano/itic/frontpage.html

Western States Seismic Policy Council Tsunami Hazard Mitigation Committee
http://www.wsspc.org/tsunami/tsunami.html

Tsunami Warning and Alerting in British Columbia, Canada
http://hoshi.cic.sfu.ca/~pep/tsunami.html

Russian Tsunami Laboratory
http://omzg.sscc.ru/tsulab

The International Journal of the Tsunami Society - Tsunami Links
http://www.ccalmr.ogi.edu/STH/links.html

"Tsunami! An On-Line Interactive Resource of Tsunami Information" sponsored by the University of Washington
http://www.geophys.washington.edu/tsunami

Waves of Destruction: Tsunamis - a PBS Special
http://www.pbs.org/wnet/savageearth/tsunami/index.html